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Development of Ornamental Fish-Keeping for Minimal Water Volume

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ABSTRACT

Over the years, more and more people have loved caring for fish as pets, but because some fish lovers are busy, some fish are neglected and tend to die without proper care. Due to these challenges, the proponent of this study aims to build an aquarium with a divider and solar power that can monitor the temperature, pH level in the water, and the water level of tanks and to automate the feeding, flaring, and water recycling processes which has an air pump. The proponent designed and fabricated the automated aquarium using an Arduino Nano microcontroller acting as a controller and relays for the different functions of the tank, such as fish feeders, blinders, and water change. The proponents conducted ten trials to ensure its reliability, precision, and accuracy and used a T-test for the statistical treatment of the study. The device achieved the study's objectives and performed it optimally. The series of trials found that the device sensed the pH level with a mean of 7.79 for automated and 8.06 for traditional, which has a significant difference with both readings, and for water temperature with a mean of 29.0067 for automated and 28.9867 for traditional, which has a no significant difference with both readings. Also, in automation, the expected water change, feeding, and flaring of the tank have been appropriately carried out as expected in the device. This can help fish hobbyists, keepers, and lovers lessen their efforts to care for their fish pets.

Keywords— Aquarium, Arduino Nano, Relays, Fish Feeder, Blinders

INTRODUCTION

Fish keeping in recent years has become a lucrative business as it only requires time, effort, and little money to invest. However, as the business grows, the fish grow in numbers, and more time and effort would be needed to sustain healthy fish as it will require a lot more attention, especially to those kept individually. Betta fish and Flower horn are the subjects of this study. Although fish keeping is a trend, some fish are mistreated, like Betta fish, as they are the least treated fish on the market. The Betta fish are sold to customers who often need to be educated about proper care, thus creating stress for the fish [1]. The Siamese fighting fish, also known as Betta, is a freshwater fish native to Thailand and declared as their National Aquatic Animal [2] [3]. With a stunning figure and attractive colorful finnage, the male Betta is the most appealing creature blood parrot and is among the first fish hybrids created by humans. While Betta fish can tolerate minimal water, Flower horns are sensitive to water parameter fluctuations. Still, they can be in a gallon tank with proper filtration and aeration [10]. Although some fish are expected to thrive under such restrictions [1] [11]- [13] this suggests that a small and poorly maintained container is inadequate for sustaining an , , which is acceptable for a breathing animal's well-being. However, in [4] the Department of Aquatic Science and Prince of Songka University in Thailand, Suktianchai Saekhow pointed out the significance of rearing male Bettas in a container with minimal water volume. This method utilizes the space taken by each container and allows them to equally ration each container with food containing substances necessary for growth, health, and good condition. This improves the immune system and appearance of young male Bettas. Regarding this method, the device changed the water frequently to eliminate uneaten fish food and excrement. In other studies, the pH level in water affects the other water parameters for fish to thrive [14]. Water must have a specific pH level for fish, other aquatic animals, and plants to thrive. Fish might become ill or die if the pH level is too low or high. Water with a low pH is acidic, whereas water with a high pH is considered alkaline [15] . Water quality affects the health of fish, and increasing pH levels can be a poison to fish.

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The key point is that the smaller the volume of the aquarium tank, the larger and the more frequent the fluctuations are, so regular water change is needed. Monitoring these fluctuations can be exhausting for some breeders and keepers. Hence, pursuing this study is necessary to minimize the effort of the fish breeders and keepers. Therefore, automating the water-changing process is appropriate for this matter. Some solutions from the Internet of Things (IoT) [16]- [19] were considered. However, some of these systems utilize a much larger tank volume, which is much more manageable than our proposed 12x8x12, which can be divided into three parts using a divider since we are going to work with an acceptable minimal water volume, immediate real-time action must be done, as small volume tanks can vary water parameters quickly.

This paper aims to build an aquarium with a divider and solar power to monitor the temperature, pH level in the water, and water level of tanks and to automate the feeding, flaring, and water recycling processes and their efficiency, which has an air pump.

Application of this system is a big help for the Ornamental fish market, hobbyists, fish lovers, and keepers, especially to the Betta fish community, allowing them to save time and effort from maintaining the water quality of a minimal-volume rearing tank that is not covered from other smart aquariums which are focused on a much larger scale.

To shorten and strengthen our discussion, only Betta fish and Flower horn are the study's subjects as their water pH level and temperature requirements are comparable. The system's tanks are plant and decoration-free to maximize the capacity. This study utilizes the area taken by each tank to optimize the quantity of fish to be groomed. It discards other options from previous studies suitable only for larger volumes.

MATERIALS AND METHODS

Conceptual Framework

Fig.1 illustrates the different variables used in the system. Fish put in the system are of the right age and size to groom and can be sold or may pertain to competition at some time, in which the inputs are the pH level, water level, and temperature. When variables like pH level and water level increase or decrease, the device will automatically fill the tank until it reaches its designated levels to see the health response of the fish.

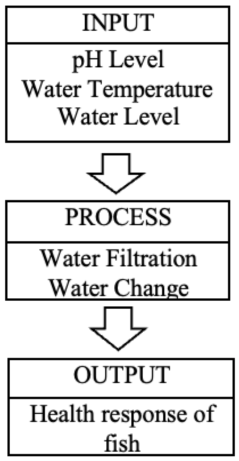

Fig. 1.Grooming System Conceptual Framework

Process Flow

While Fig. 2 shows the general process of the Grooming System. The key to having healthy fish is the water parameter. Materials and methods are carefully analyzed to achieve the ideal environment for each fish species. The Grooming System sensors closely measure the pH level in the Grooming tank environment using a submersible water sensor, indicating when and how the actuators would operate. Water change is scheduled each day morning and afternoon; 30% of the water in the tank must be drained to suck the excrement and other debris and fill another 30% to maintain the water level, and 15% must be drained and filled after each feeding. This will reduce the risk of polluting the Grooming tanks by frequently changing the water and sucking up uneaten food and excrement. The system recycles the wastewater through a series of filters and water conditioner tanks with the help of water pumps. First, wastewater will go down through the sump filter, which will filter the sediments and the like. The minimal water volume aquarium architecture comprises a sensor, motor, and control panel.

The device's hardware monitors the pH and water levels of the tank and controls the system by automating water change and feeding. The Arduino Mega executes the data that was transmitted by the sensor.

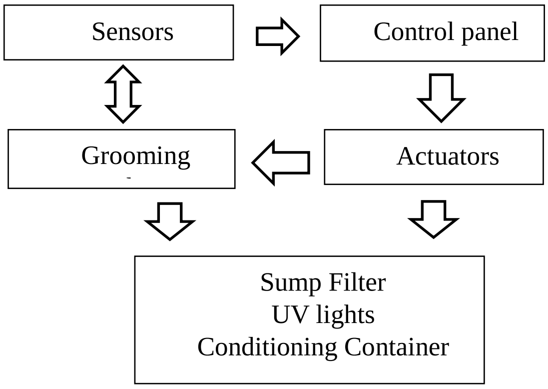

Fig. 2. Monitoring and Control System Block Diagram

The control system of the fabricated system includes different components such as a water pump, fish feeder, aerator, stepper, and servo motor. The user can set conditional statements (if-then statements) using the data from the sensors as input variables. The researchers were able to design a reliable control system that accurately follows the study's objective. To check the working reliability of the control system, it is simulated using the computer software Proteus 8 Professional.

Design and Fabrication

The system uses a minimum tank size for each fish species to utilize the space taken by each tank while not compromising the health and well-being of the creatures. Tank sizes are as follows: For the Betta fish, 4x6x8 cubic inches. The flower horn is 12x8x12 cubic inches, and the water recycling tank is 20x13x13 cubic inches. Sensors such as pH level sensor, temperature sensor, and ultrasonic sensor sense the different parameters in the water and send them to Arduino, then give commands to the different major components of the device such as aerator, pump, stepper motor, and servo motor.

When the set time arrives, the pump pumps water to the tank, or the pH level threshold drops or increases as for the aerator, which is only active when the fish we used in the device is flower horn as flower horn is very sensitive to the amount of oxygen. The stepper motor is used for the tank drain, and the servo motor is used for the feeder. Also, the device used a 100-watt solar panel and a 12V, 5 Ah battery to power the device.

Aquarium Functionality Test

For the functionality test, IEC 61730-1:2016 specifies the prevention of electric shock, fire hazards, and personal injury for health and safety. Regarding the environmental component, ISO/TC 234 – Standardization in the field of fisheries and aquaculture covers a variety of topics, such as terminology, technical requirements for equipment and how it operates, site characterization, maintaining suitable chemical, biological, and physical conditions, environmental monitoring, data reporting, traceability, and waste management. For its sustainability, the guidelines for adhering to ISO 20121:2012's standards for an event sustainability management system apply

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to all events and event-related activities. For software function tests, ISO/IEC/IEEE 29119-2 will be used to gather information.

1) Sensors: To ensure the accuracy of pH level and water level sensors, they will be tested 30 times each. Manual testing will also be done to compare the actual sensor reading.

2) Control system: For automation, see Fig. 3. Submersible water pump, stepper motor, and fish feeder will be tested 10 times to ensure it's working.

3) Safety: For the safety of fish during a water change, the mesh will be put 1 inch at the tank's bottom to ensure that the fish will not be drained together during water changes.

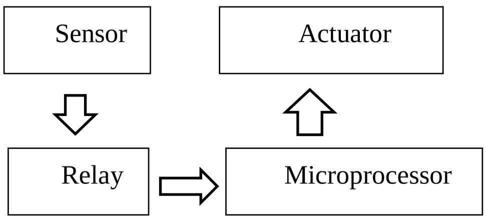

Fig. 3. Function Test Block Diagram

Data Analysis

The researcher conducted an independent sample T-test to compare actual and sensor readings for Betta fish. The readings were compared to see if there was a mean significant difference in both readings.

RESULTS AND DISCUSSIONS

Previous studies found that water volume is the key parameter in fishkeeping to improve the health of the fish; moreover, water volume significantly affects specific activities of the digestive enzymes [4]. This study focuses on automating the maintenance of fish health and vitality while observing the water parameters that fish need for optimal living conditions.

Ornamental Fish-Keeping Device

As shown in figure 4. The researcher built the device based on the parameters and objectives; the researchers achieved the desired objective. The device mainly comprises a sensor, microcontroller, and actuator. Using a controller, Arduino Nano sends commands to the actuators and then performs the tank's feeding, flaring, and water change. On the other hand, the sensor detects the water parameters and sends the reading to the microcontroller to be displayed in LED for real-time monitoring.

Fig. 4. Automated Device

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The researcher gathered data, compared the water parameters, and analyzed them in automated and manual fishkeeping devices. In addition, the researcher gathered the amount of time used for fishkeeping and wasted water in manual fishkeeping.

The researchers chose Betta fish as a test subject. For Betta fish, the researchers measured the water parameters such as pH level and water temperature in the automated and manual fishkeeping setup. For manual fishkeeping, the researchers changed 30 percent of the water volume every day for ten(10)days to simulate the working condition of the device. Also, the researchers measured the pH level and water temperature three (3) times a day every five (5) hours for ten (10) days on the following water parameters: pH level and water temperature.

pH Level

As shown in Fig. 5 (Comparison of pH level of Automated and Traditional method), the graph compares the pH level between our automated fishkeeping device and the traditional fishkeeping. The graph exposed the differences in pH level for statistical result analysis. It shows that the pH level in our automated fish-keeping device (Orange Bar) within the thirty (30) trials as the x-axis and the y-axis as the degree of threshold of pH level for both devices, which is still within our designated threshold compared to traditional fish-keeping (Blue Bar), in which the pH level steadily rises beyond the designated threshold. In comparison, in the 19th to 30th trial in both methods, there was a significant increase in pH level in the traditional method, which indicates the effectiveness of the automated method in maintaining the pH parameter required for the fish to thrive. It also observed that from the 22nd to the 30th, the algae slowly accumulated in the tank of the traditional method. The data gathered from the automated fish-keeping device (M =7.79, SD=.198) showed a significant pH level difference compared to traditional fish-keeping (M =8.06, SD=.398). The result of the independent t-test with 95% accuracy conducted by the researchers showed that the traditional method dramatically affects the pH level of the water.

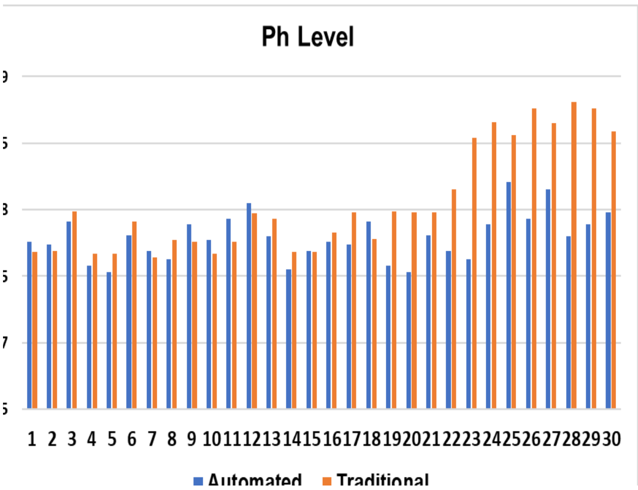

Fig. 5. Comparison of pH level of Automated and Traditional method

Water Temperature

The researcher gathered data on temperature using both automated and traditional methods of fish keeping for ten(10) days three(3) times a day. As shown in Fig. 6 (Comparison Of Water Temperature of Automated and Traditional method), the temperature for both the automated (blue bar) and traditional (orange bar) method is shown. The x-axis corresponds to the 30-day number of trials, and the y-axis is the degree temperature level in Celsius for both devices. The data was gathered from the automated fish-keeping device for water temperature (M =29.0067, SD=1.45055) compared to traditional fish-keeping (M =28.9867, SD=1.49222). Comparing the results using a t-test showed no significant difference between automated and traditional fishkeeping.

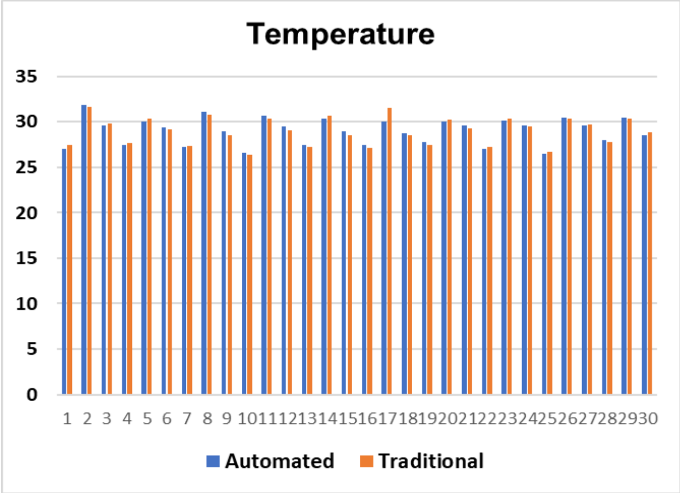

Fig. 6. Comparison of Water Temperature of Automated and Traditional Methods

Water-Saving System

1. Wasted water: The researcher changes thirty (30) percent of the tank's water volume daily for ten x days to see how much water is wasted in the traditional method using Equation 1.

$$V=\pi r2h \qquad (1)$$

Where I is the radius, which is (r= 8cm), and (h) is the height, which is (h= 18cm). The researcher measured thirty (30) percent of the height (h=18cm), which is (5.4cm). The researcher gathered the total volume of wasted water using the traditional method from day 1 to day 10, neglecting the evaporated amount of water. The wasted water amounted to 10857.344 cubic centimeters of water. The amount of water wasted in the traditional method indicates the efficacy of the automated fish-keeping device, which recycles and recirculates the water back to the tank.

2. Time Consumption: Unlike our automated fish-keeping device, which does not require constant attention from the keeper, the traditional method consumes time to keep the fish alive. Hence, the researchers gathered the total amount of time and average time used in changing water, feeding, and flaring in traditional fish keeping. For water change, as mentioned above, thirty (30) percent of water is being changed every day. For water change, the researcher gathered a total time consumed in changing thirty percent of water volume in ten (10) days, which is 546 seconds, and the average time consumed is 54.6 seconds.

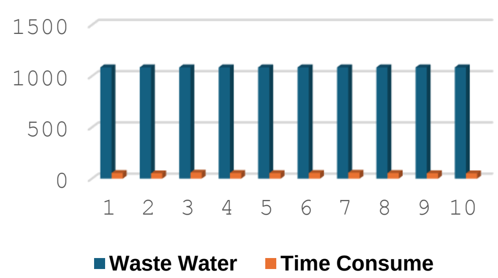

Fig. 7. Comparison of Wastewater and Time Consume

Time Consume in Traditional Fish Keeping

Fig. 7 shows the relationship between the 10-day number of trials as the x-axis versus the magnitude value of the water in ml and time in seconds as the y-axis. For flaring, the researcher gather the data for ten (10) days three (3) times a day; the total amount of time consumed in flaring is 313 seconds, and the average time consumed is 10.43 seconds. For feeding, the researcher gathers the data for ten (10) days three (3) times daily. The total time consumed in flaring is 216.5 seconds, and the average time consumed is 7.22 seconds.

Existence of Betta Fish

The researchers observed and monitored the well-being of the fish. The researcher gathered the pH level, Water temperature, and time consumed in automated and traditional fish keeping using a pH meter, thermometer, and watch. The fish subject to the trial of our automated fish-keeping device and traditional fish-keeping are all matured Betta fish. On the 1st day of the trial, both Betta fishes in the automated and traditional are in the threshold parameter of pH level. Still, as the days go until the 10th day of the trial, the pH level in the traditional method is observed to exceed the threshold. It is also observed that watercolor, using the traditional method, becomes cloudy.

As for the temperature in both methods mentioned above, the difference is small because the tanks were placed in the same room environment. Throughout the 10-day trial, except for the pH level that passed the threshold and cloudy water in the traditional method, there was no problem and no mortality in both automated and traditional methods. Fig. 8 also shows below the observation of the water environment of the fish on day 1 for automated fish-keeping, and Fig. 9, which is for day 10. The Fig. 10 is the water observation for traditional fish-keeping on day 1, and the Fig. 11 is the water observation on the 10th day. Based on the water observation, both have differences, meaning automated fish-keeping has more advantages in the fish environment than the traditional one.

Fig. 8. Day 1 Automated Fish-keeping

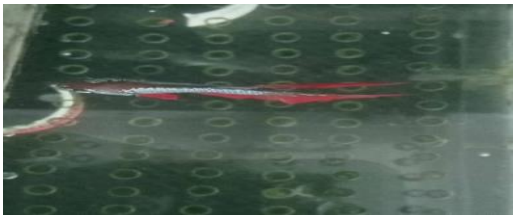

Fig. 9. Day 10 Automated Fish-keeping

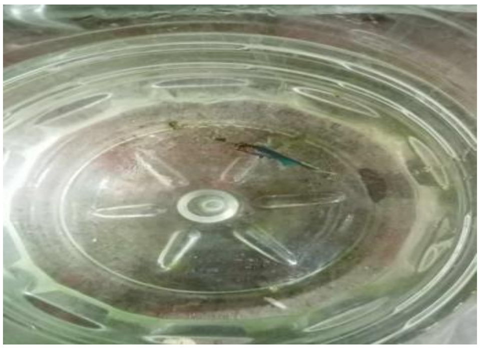

Fig. 10. Day 1 Traditional Fish-keeping–

Fig. 11. Day 10 Traditional Fish-keeping

CONCLUSIONS AND FUTURE WORKS

This research shows that an automated aquarium with a monitoring system could monitor parameters such as water temperature, pH level, and water volume in real-time and save time and water. Sensors were interfaced with Arduino Uno with LCD display. It can also control the different parts of the device set for the type of fish using relays such as fish feeders, blinders, aerators, and submersible water pumps. Therefore, the automation of fish tanks lessens the effort of the fish keepers to take care of their fish pets, especially to ensure that their fish pet is provided with regular feeding and regular cleaning, to those busy people who love to take care of fish but do not have enough time because of work and the like.

For future work, researchers can design a more advanced device that is more efficient and has more functions. It is also suggested that the device have two power sources to operate constantly. This will guarantee that the device has a 2nd option if one power source fails and cannot sustain the overall power consumption of the device. During our test, it was observed that our flaring device was not working because our divider was soaked in water because of a leak, which hindered our stepper motor. To avoid such an anomaly in the operation of the device, it is recommended that all parts of the device be checked thoroughly for optimal operation. It is also prescribed to perform the traditional method to compare to the automated so that the advantage of the automated method is verified. Also, check your device battery and measure the device when testing is recommended.

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